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LISTS OF SPECIES

Fish fauna of headwater streams that cross the Atlantic Forest of south São Paulo state

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ABSTRACT: The fishes of the present study were collected in the headwater streams of the Sorocaba, Paranapanema and Ribeira de Iguape river basins during the dry period in 2010. A total of 2892 fishes, grouped in 53 species, were captured. The composition of the ichthyofauna captured in the streams of Sorocaba and Paranapanema river basin was greatly similar. On the other hand, the fish fauna of the streams of Ribeira de Iguape river basin were quite different from the ones captured in the others basins, with the occurrence of endangered species (*Isbrueckerichthys epakmos* and *I. duseni*) and exotic species (*Misgurnus anguillicaudatus*). The previous list of fish for the Sorocaba river basin increased with the addition of seven species of Characiformes, one Gymnotiformes and four Siluriformes.

INTRODUCTION

Despite knowing that no species of fish is totally extinct in the aquatic ecosystem of São Paulo state, we know that the small headwater streams are quickly and negatively being altered by anthropogenic interventions in their drainage basins (Castro and Menezes 1998). Some species that occur in these environments may have become extinct without prior scientific knowledge.

The area of interest is spatially heterogeneous characterized by diverse interacting patches ranging from human-dominated environments to conservation units. The basin of the Sorocaba river (Tietê river basin) is the most altered due to human activities, followed by the basin of Alto Paranapanema. On the other hand, the Ribeira de Iguape river basin has native vegetation and a high number of Conservation Units in a large portion of its area.

The Maciço de Piedade, on the Serra de Paranapiacaba has a high heterogenic relief, contributing to the formation of numerous small-size watercourses. In this region, drainage basin is separated topographically by the Serra de Paranapiacaba that represents a geographical barrier of the adjacent basins of Sorocaba, Paranapanema and Ribeira de Iguape rivers. This situation stimulated the present study, aiming at presenting the composition of the fish communities from the headwater streams belonging to the three hydrographic basins.

MATERIALS AND METHODS

The hydrographic basin of the Sorocaba river and middle Tietê (UGRHI 10) is characterized by a well developed industrial pole, a deficit in vegetative covering in the areas of permanent preservation that range between 80 and 95% and a population density of about 140 inhabitants/km^2. Within this area lie the headwaters of the Sorocaba, Pirapora and Sarapuí rivers (IPT 2006). The headwaters of the Turvo river are inserted in the UGRHI 14, corresponding to the hydrographic basin of the Alto Paranapanema that presents agricultural characteristics, a population density of around 30 inhabitants/km^2 with about 15% of native vegetation and headwaters covered by reforestation areas and natural forests (CETEC 1999). The UGRHI 11 includes the hydrographic basins of the Ribeira de Iguape and Litoral Sul. About 60% of its territory has native vegetation and it has a population density of about 15 inhabitants/km^2 (CETEC 2000). Given its physical conditions, it has the potential for conservation, with Conservation Units covering most part of its territory.

During the dry period in 2010 (July – November), we sampled the ichthyofauna in ten 100m-sections of streams in the Sorocaba river basin (Table 1), eight in the Paranapanema river basin (Table 2) and nine in the Ribeira de Iguape river basin (Table 3), totalizing 27 surveys carried out in the municipalities of Piedade, Pilar do Sul, Ibiúna, Tapiraí and Salto de Pirapora (Figure 1).

The ichthyofauna was sampled using electric fishing equipment (License n° 13352-1 SISBIO/IBAMA/MMA and 260108-004.423/2010 SMA). The organisms collected were stored in the fish collection of the Ichthyology Laboratory, Zoology and Botany Department of the UNESP – São José do Rio Preto (DZSJRP 13618-13705). The Sorensen index (IS) was applied aiming at quantifying the similarity in the fauna composition between basins.

RESULTS AND DISCUSSION

A total of 2892 fish were captured, being 89% smaller than 100mm of total length (CT), grouped in 53 species (81% < 100mm CT). The size agrees with comments by Castro and Menezes (1998) who, when referring to

the fish fauna that live in the headwater streams of the hydrographic basins of São Paulo state, highlighted that the species are small-sized, limitedly distributed, have little or no commercial value and show a strong dependence on the riparian vegetation as a food source of non-native (alloctone) origin, for reproduction and protection.

In the streams of the Sorocaba and Paranapanema river basins 28 species were captured, while in the Iguape river basin 23 species were collected (Table 4). The specific composition of the streams of the Ribeira de Iguape river basin was quite different from the ones captured in the Sorocaba and Paranapanema basins (IS_{RI-S} = 0.27 and IS_{RI-P} = 0.31). On the other hand, there is a great similarity between the ichthyofauna of the streams of the Sorocaba and Paranapanema river basins (IS_{S-P} = 0.68). Such results confirm our expectations, since the streams of the Sorocaba and Paranapanema river basin are part of the Alto Paraná basin, and this justifies the high similarity in the fauna composition. Furthermore, since the Ribeira de Iguape river basin is smaller than the Alto Paraná basin, observing less species richness in the streams of the Ribeira de Iguape basin is what one would expect according to the species-area relationship.

According to Oyakawa and Menezes (2011), 97 documented species currently exist in the Ribeira de Iguape river basin and close to 45% occur exclusively in this basin. This could be the cause of the endemism in these watercourses. The present study sampled only the headwater streams and 15 of the 23 species collected (65%) were exclusive, something that could be a result of the stronger endemism in these watercourses. Furthermore, *Isbrueckerichthys epakmos* and *I. duseni,* species in danger of extinction according to Oyakawa *et al.* (2009), were captured in this study. It is also worth highlighting the capture of *Misgurnus anguillicaudatus*, an exotic species originally from Asia in a stream in the Ribeira de Iguape river basin. This species has a great past in ecological impacts following its introduction (Froese and Pauly 2011).

On the other hand, individuals of *Phalloceros reisi*, *Hypostomus ancistroides*, *Rhamdia quelen*, *Hoplias malabaricus* and *Gymnotus silvius* were collected in the streams of the three basins, reflecting their wide geographic distribution (Buckup *et al.* 2009, Oyakawa and Menezes 2011). Up to now, five species were captured that had an undefined taxonomic *status*, given that two are from the Characiformes order and three from the Siluriformes. This situation reflects the affirmation that, despite the Alto Paraná watercourses being the most well-studied in South America regarding the ichthyofauna, its richness (391 species) is far from representing reality, mainly taking into consideration the new descriptions coming from the streams and headwater environments (Langeani *et al.* 2007).

Aiming at updating the list of species published by Smith *et al.* (2007), that recorded the occurrence of 71 species for the Sorocaba river basin, seven Characiformes species are added: *Astyanax paranae*, *Hyphessobrycon anisitsi*, *Piabina argentea*, *Characidium gomesi*, *Characidium oiticicai*, *Characidium zebra*, *Apareiodon ibitiensis*; one Gymnotiformes: *Gymnotus silvius*; and four Siluriformes: *Cetopsorhamdia iheringi*, *Pimelodella avanhandavae*, *Hypostomus variipictus*, *Trichomycterus iheringi*. This addition is probably related to the collecting equipment since Smith *et al.* (2007) used gillnets, sieves and *puçás* (a sort of funnel net), while in the present study only electric fishing has been used and our samples were carried out solely in the headwater streams.

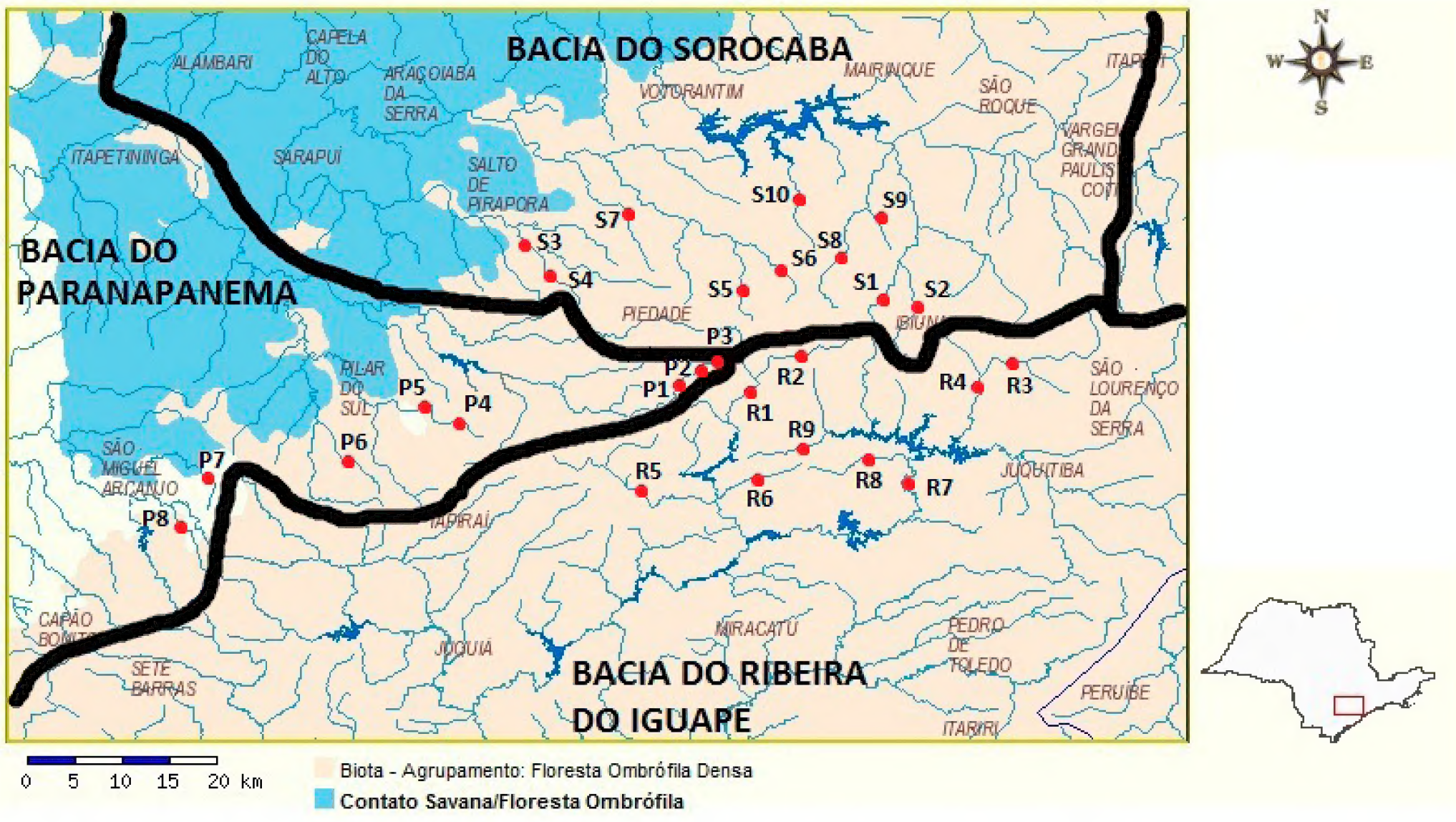

Figure 1. Boundary of the Sorocaba, Paranapanema and Ribeira de Iguape river basins and streams sampled (Font: http//sinbiota.cria.org.br/atlas/)

Table 1. Geographic location of the sampled sections including its identification, municipality, sub-basin specification in the Sorocaba river hydrographic basin.

ID	STREAM	MUNICIPALITY	SUB-BASIN	LONG	LAT
S1	Murundu	Ibiúna	Sorocabuçu	47°15'24"	23°48'40"
S2	Paiol	Ibiúna	Sorocabuçu	47°11'29"	23°48'08"
S3	Sarapuí	Salto de Pirapora	Sarapuí	47°35'31"	23°42'37"
S4	Sarapuí	Salto de Pirapora	Sarapuí	47°33'18"	23°44'47"
S5	Furnas	Piedade	Pirapora	47°21'29"	23°48'13"
S6	Piraporinha	Piedade	Pirapora	47°20'28"	23°47'28"
S7	Liberdade	Piedade	Pirapora	47°27'00"	23°43'02"
S8	Salto	Piedade	Una	47°17'13"	23°46'26"
S9	Cupim	Ibiúna	Una	47°13'44"	23°43'21"
S10	Colégio	Ibiúna	Colégio	47°18'33"	23°41'59"

Table 2. Geographic location of the sampled sections including its identification, municipality, sub-basin specification in the Paranapanema river hydrographic basin.

ID	STREAM	MUNICIPALITY	SUB-BASIN	LONG	LAT
P1	Turvo	Pilar do Sul	Turvo	47°25'05"	23°51'47"
P2	Afluente Turvo	Piedade	Turvo	47°24'07"	23°51'38"
P3	Turvo	Pilar do Sul	Turvo	47°24'14"	23°51'25"
P4	Clarinho	Pilar do Sul	Pinhal	47°42'46"	23°53'22"
P5	Claro Grande	Pilar do Sul	Pinhal	47°42'47"	23°53'23"
P6	Pinhal	Pilar do Sul	Pinhal	47°46'14"	23°53'19"
P7	Guarapu	S.M. Arcanjo	Turvo	47°52'32"	23°57'41"
P8	Lageado	S.M. Arcanjo	Turvo	48°01'00"	23°59'47"

Table 3. Geographic location of the sampled sections including its identification, municipality, sub-basin specification in the Ribeira de Iguape river hydrographic basin.

ID	STREAM	MUNICIPALITY	SUB-BASIN	LONG	LAT
R1	Grande	Piedade	Peixe	47°19'40"	23°50'36"
R2	Ponte de Tábua	Piedade	Peixe	47°17'05"	23°49'39"
R3	Vargens	Ibiúna	Juquiá	47°14'29"	23°51'18"
R4	Vargens	Ibiúna	Juquiá	47°14'36"	23°51'46"
R5	Areias	Tapiraí	Juquiá-Guaçu	47°27'08"	24°01'50"
R6	afluente Juquiá-Guaçu	Ibiúna	Juquiá-Guaçu	47°16'36"	24°00'33"
R7	afluente Juquiá-Guaçu	Ibiúna	Juquiá-Guaçu	47°13'23"	23°58'19"
R8	Bonito	Ibiúna	Juquiá-Guaçu	47°15'57"	23°57'27"
R9	Bagres	Ibiúna	Juquiá-Guaçu	47°17'31"	23°55'44"

Table 4. List of captured species in the headwater streams of the three hydrographic basins.

	PARANAPANEMA	SOROCABA	RIBEIRA DE IGUAPE
Characiformes			
Characidae			
Astyanax altiparanae Garutti and Britski, 2000	x	x	
Astyanax bockmanni Vari and Castro, 2007	x		
Astyanax fasciatus (Cuvier, 1819)	x	x	
Astyanax paranae Eigenmann, 1914	x	x	
Astyanax ribeirae Eigenmann, 1911			x
Astyanax sp.			x
Astyanax sp2			x
Bryconamericus iheringi (Boulenger, 1887)		x	
Bryconamericus microcephalus (Ribeiro, 1908)		x	
Bryconamericus stramineus Eigenmann, 1907	x		
Deuterodon iguape Eigenmann, 1907			x
Hyphessobrycon anisitsi (Eigenmann, 1907)	x	x	x
Piabina argentea Reinhardt, 1867	x	x	
Crenuchidae			
Characidium gomesi Travassos, 1955	x	x	

Table 4. ***Continued.***

	PARANAPANEMA	SOROCABA	RIBEIRA DE IGUAPE
Characidium lanei Travassos, 1967			x
Characidium oiticicai Travassos, 1967	x	x	
Characidium pterostictum Gomes, 1947			x
Characidium schubarti Travassos, 1955	x		
Characidium zebra Eigenmann, 1909	x	x	
Erythrinidae			
Hoplias malabaricus (Bloch, 1794)	x	x	x
Parodontidae			
Apareiodon ibitiensis Campos, 1944		x	
Parodon nasus Kner, 1859		x	
Gymnotiformes			
Gymnotidae			
Gymnotus pantherinus (Steindachner, 1908)			x
Gymnotus silvius Albert and Fernandes-Matioli, 1999	x	x	x
Siluriformes			
Callichthyidae			
Callichthys callichthys (Linnaeus, 1758)		x	
Corydoras aeneus (Gill, 1858)		x	
Heptapteridae			
Cetopsorhamdia iheringi Schubart and Gomes, 1959	x	x	
Imparfinis mirini Haseman, 1911	x	x	
Imparfinis borodini Mees and Cala, 1989	x		
Phenacorhamdia tenebrosa (Schubart, 1964)	x		
Pimelodella avanhandavae Eigenmann, 1919	x	x	
Pimelodella transitoria (Ribeiro, 1907)			x
Rhamdia quelen (Quoy and Gaimard, 1824)	x	x	x
Loricariidae			
Harttia kronei Miranda-Ribeiro, 1908			x
Hisonotus sp1	x		
Hypostomus ancistroides (Ihering, 1911)	x	x	x
Hypostomus variipictus (Ihering, 1911)		x	
Isbrueckerichthys duseni (Miranda-Ribeiro, 1907)			x
Isbrueckerichthys epakmos Pereira and Oyakawa, 2003			x
Neoplecostomus ribeirensis Langeani, 1990			x
Neoplecostomus cf. *yapo* Zawadzki, Pavanelli and Langeani, 2008	x		x
Neoplecostomus sp.		x	
Rineloricaria pentamaculata Langeani and Araújo, 1994	x		
Trichomycteridae			
Ituglanis proops (Miranda-Ribeiro, 1908)			x
Trichomycterus iheringi (Eigenmann, 1917)		x	
Trichomycterus cf. *zonatus* (Eigenmann, 1918)			x
Trichomycterus sp.	x		
Cyprinodontiformes			
Poecilidae			
Phalloceros reisi Lucinda, 2008	x	x	x
Synbranchiformes			
Synbranchidae			
Synbranchus marmoratus Bloch, 1795	x	x	
Perciformes			
Cichlidae			
Australoheros facetus (Jenyns, 1842)	x	x	x
Geophagus brasiliensis (Quoy and Gaimard, 1824)	x	x	
Geophagus iporangensis Haseman, 1911			x
Cypriniformes			
Cobitidae			
Misgurnus anguillicaudatus (Cantor, 1842)			x

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